Load Redistribution in Standing, Tilt-in-Space, and Reclining Wheelchairs

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Purpose

This study investigated load redistribution during tilt, recline and standing under the weight bearing areas of the body, specifically the seat and back.

Subjects

- 6 able-bodied subjects
  - 2 male, 4 female
  - 21-42 years old (mean: 25)
- 10 subjects with spinal cord injury
  - 8 male, 2 female
  - 19-59 years old (mean: 35.5)
  - C4-T12 levels of injury, ASIA A-D

Instrumentation

- Levo combi power wheelchair
  - Flat foam 3” seat cushion
  - Flat foam 1” back cushion
- Tekscan pressure mapping system
  - Four CONFORMAT 5315QL TEKSCAN sensor mats

Methods

- Pressure mats placed under cushion, backrest, on headrest and footrest
- Subjects transferred to power chair. Neutral position of seating system was level seat and 100 back angle for all configurations

Methods

- 5 angles throughout full range of tilt (55), recline (180) and stand (75)
- Order of position and angles randomized
- Data was collected after one minute at each configuration

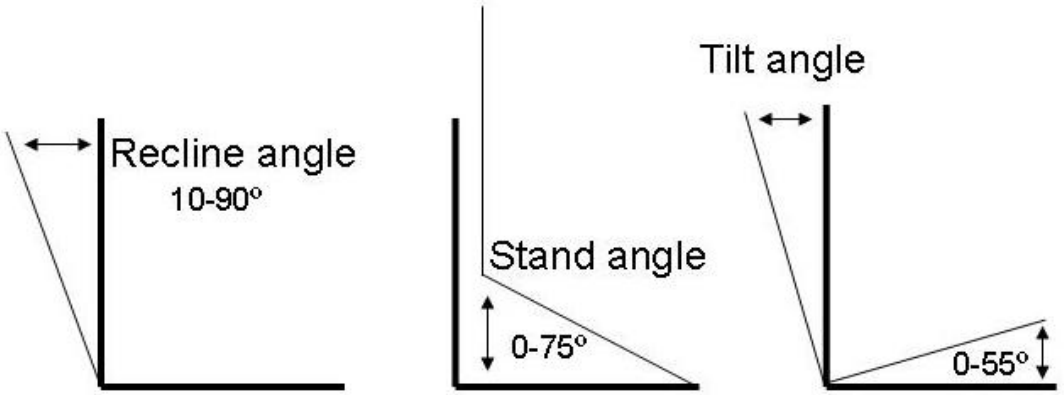


Figure 1: Angle definitions & ranges

Data Analysis

- Pressure output converted to force
- Force values normalized to the maximum force for a given mat and seat configuration (recline/stand/tilt)
- Linear regression performed to model the relationship between the angle of recline, stand and tilt and load on the seat/back

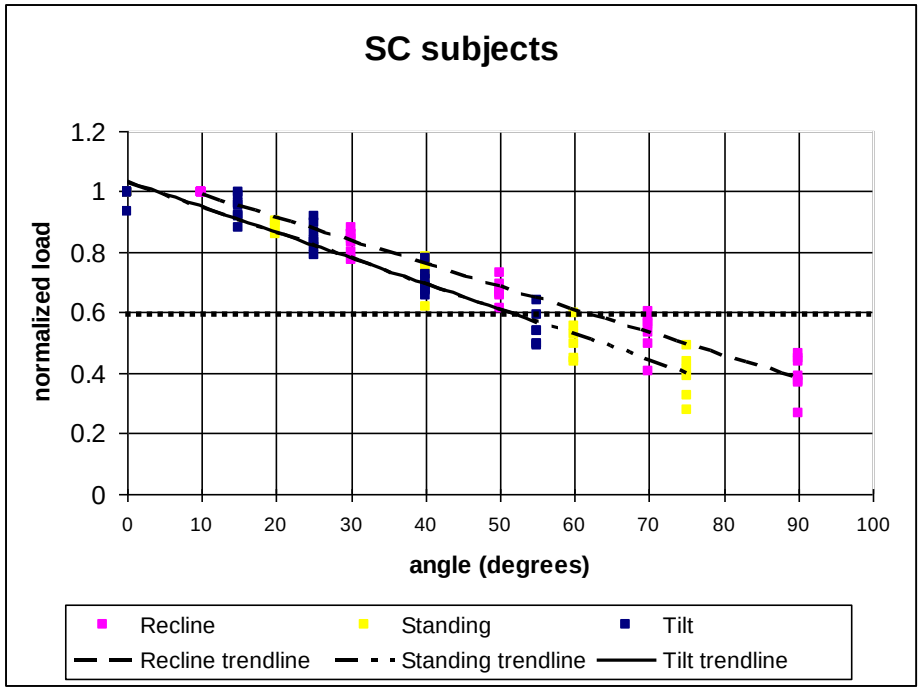
Results

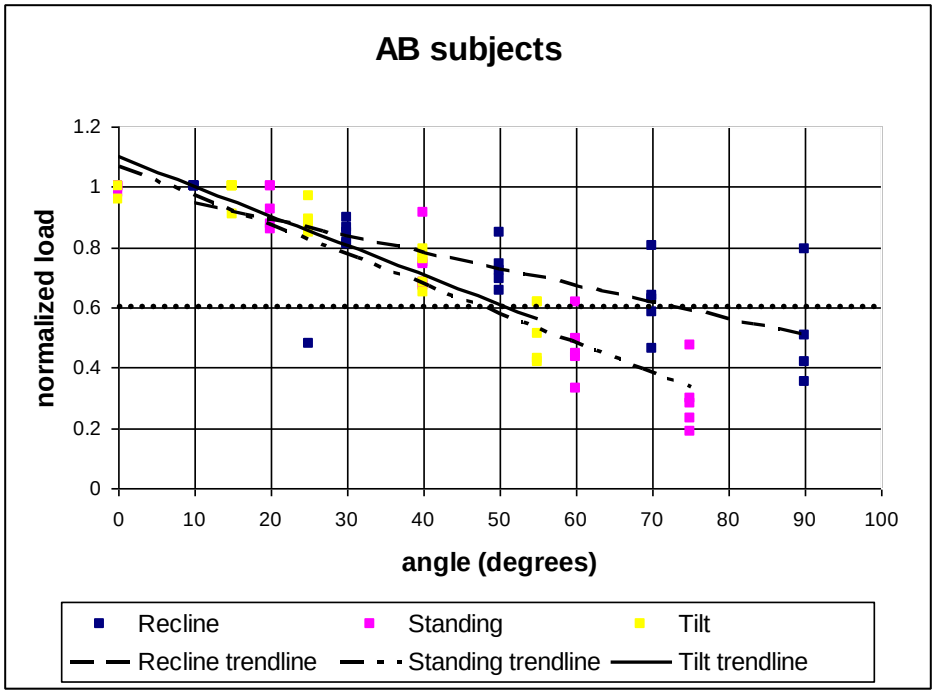
R^2 Values of angle vs. normalized force

	Ab R^2		SC R^2	
	Seat	Back	Seat	Back
Recline	0.78	0.88	0.96	0.89
Stand	0.88	0.73	0.94	0.75
Tilt	0.84	0.93	0.91	0.93

Results

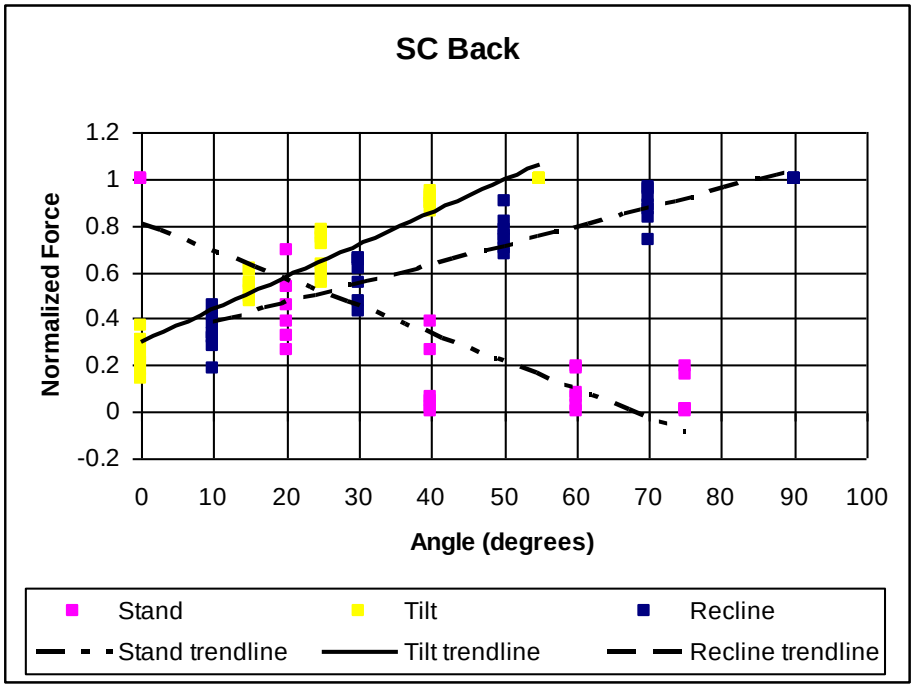
Seat forces

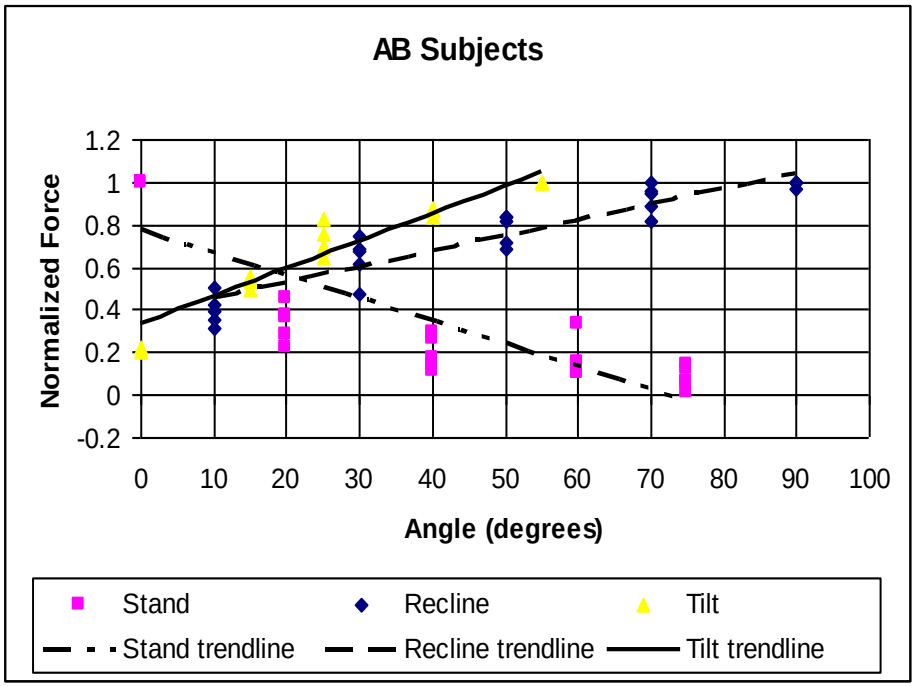




Results

Back forces





Discussion

- A linear relationship exists between seat/back load and degree of recline, stand or tilt for both AB and SC subjects

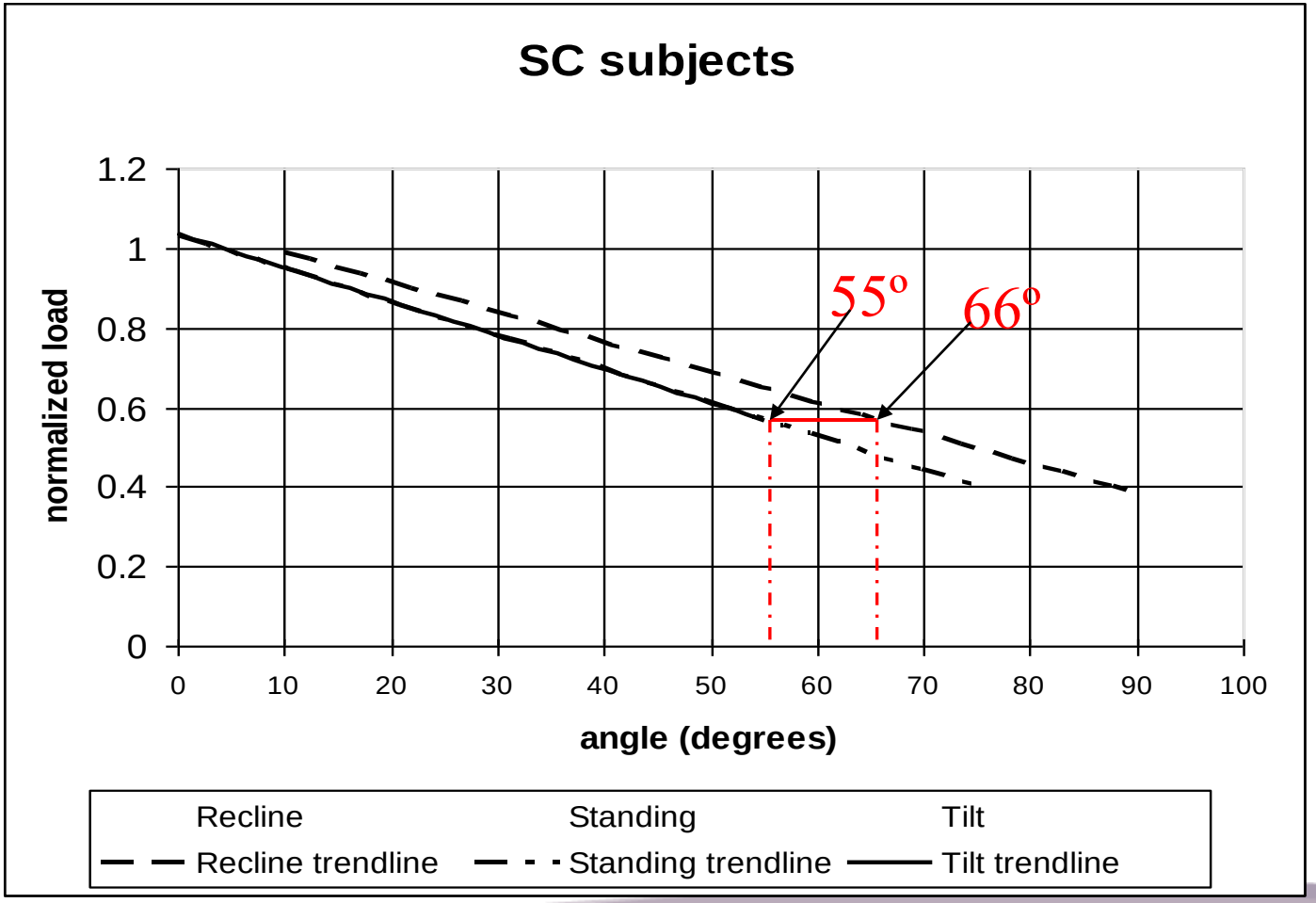
- The slope differed for AB compared to SC subjects indicating that load re-distribution differed between the 2 groups

Discussion

- The maximum decrease in load on the seat occurred at full standing and full recline in SC subjects
- The maximum decrease in load on the seat occurred at full standing in AB subjects

	SC	AB
Recline	62%	49%
Tilt	43%	44%
Stand	62%	67%

Discussion


SC subjects
normalized load
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
90
100
angle (degrees)
55°
66°
Recline
Standing
Tilt
Recline trendline
Standing trendline
Tilt trendline

Conclusion

- Decreases in load on the seat occurred in a linear fashion over the ranges studied, so no threshold point could be identified to define an 'effective' tilt, recline or stand.
- Clinicians and users should be aware of the degree of position change since not all users reach the end range of movement.

Conclusion

- The results indicate that standing may be considered as a means of unloading the seat for a weight shift for people with spinal cord injuries.
- Standing provides a functional position from which to continue daily activities while unloading the seat, vs. tilt/recline.
- Additional study is needed to relate position changes to physiological effects to better discern how much position change is needed within a strategy.